REMARKS

The application and September 17, 2004 Office Action have been reviewed. The specification, Abstract and claims have been amended and the application is now believed to be in condition for allowance.

The Examiner is thanked for noting allowable subject matter. Claim 4 [sic, 5] would be allowable if rewritten to overcome the rejections under 35 USC § 112, second paragraph, and include all of the limitations of the base claim and any intervening claims.

In the Action, the Examiner objected to the disclosure in several aspects. Specifically, the Examiner objected to the language, format and length of the abstract and required correction. The Examiner objected to an embedded hyperlink in the specification and required its deletion. The Examiner objected to the specification as missing page 16 and required correction. The Examiner also suggested that the specification be amended to provide proper idiomatic English. The Examiner noted the acceptance of the as-filed drawings and acknowledged receipt of certified copies of the priority documents. The Examiner rejected claims 1-5 under 35 USC § 112, second paragraph, as being indefinite. Claims 1-4 were rejected under 35 USC § 103(a) as being obvious over Applicant's Admitted Prior Art (AAPA) in view of any one of Kubota et al. (U.S. Patent No. 5,991,954), Landry et al. (U.S. Patent No. 2,290,987) and Nishimura et al. (U.S. Patent No. 4,704,963). The Examiner also indicated consideration of the Information Disclosure Statement by returning an initialed copy of Form PTO-1449.

With respect to the objections the Abstract and specification, they have both been reviewed and amended, as follows:

1) The Abstract of the Disclosure has been shortened to comply with MPEP § 608.01(b). The word "means" has also been deleted from this section to comply with the Examiner's citation.

2) The referenced embedded hyperlink has been deleted to comply with MPEP § 608.01.

3) The missing last page of the specification (page 16) is again provided. (It should be noted that the filing receipt postcard indicates that all pages of the specification were submitted when the application was filed.)

4) The specification, except for the original claims portion in which all claims are being replaced by amendments in response to this Office Action, has been amended to be in proper idiomatic English in compliance with 37 CFR 1.52(a) and (b) without a full retranslation. No new matter has been added. Two versions are provided: an edited version with the actual changes made to the original specification and a clean version with the changes incorporated. A marked up specification is attached as Appendix A and a substitute specification is attached as Appendix B. A substitute Abstract is also presented. Reconsideration and withdrawal of the objections to the specification and Abstract are respectfully requested.

Turning to the claims, claims 1-4 are cancelled without prejudice to the subject matter therein. However, the Examiner stated claim 4 would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112, second paragraph, set forth in the Office Action and to include all of the limitations of the base claim and any intervening claims. After reviewing the Office Action and the original claims, the Applicant believes that the Examiner actually meant claim 5 instead. New claim 6 is presented to incorporate the desired limitations of claims 1-5 as well as to modify the last portion of claim 5 for clarity and to otherwise

overcome the § 112 rejection. Claim 5 is amended and made dependent on new claim 6 and amended for clarity. Reconsideration and withdrawal of the rejections of the claims are respectfully requested.

As all grounds of objection and rejection have been addressed and overcome, entry of this Amendment and issuance of a Notice of Allowance of the claims, as now presented, are respectfully solicited.

In the event that there are any questions relating to this Amendment or to the application in general, it would be appreciated if the examiner would telephone the undersigned attorney concerning such questions so that the prosecution of this application may be expedited.

Please charge any shortage or credit any overpayment of fees to BLANK ROME LLP, Deposit Account No. 23-2185 (000560-00123). In the event that a petition for an extension of time is required to be submitted herewith and in the event that a separate petition does not accompany this response, Applicant hereby petitions under 37 C.F.R. 1.136(a) for an extension of time for as many months as are required to render this submission timely.

Any fees due are authorized above.

Respectfully submitted,

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Attachments: Appendix A
Appendix B
Substitute Abstract (end of Appendix B)

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PERIPHERAL LENGTH CORRECTION DEVICE OF METAL RINGS

BACKGROUND OF THE INVENTION

The present invention relates to a peripheral length correction device of metal rings, and more particularly to a peripheral length correction device used ~~to for~~ correcting the peripheral length of metal rings which constitute a V-belt type ~~c~~Continuously ~~v~~Variable ~~t~~Transmission belt (hereinafter referred to as "CVT belt").

Conventionally, there is a known CVT belt which is structured by layering about ten thin metal rings of 0.2 mm thickness in succession with steel metal elements inserted therein~~. For example~~, as disclosed in "REALIZATION OF THE IDEAL MAXIMUM PERFORMANCE OF A CVT TRANSMISSION" by Tomomi Miyaji~~,~~ (non-patent literature), ~~[on line], [searched on August 25, 2002], Internet <URL: http://www.idemitsu.co.jp/lube/cvtbody2.html> and illustrated in FIG. 4 of this homepage~~.

The CVT belt of such a structure is manufactured as follows. First, the ends of the thin sheet metal, which are made of ~~super strong~~ ultrahigh-strength steel such as marageing steel, are welded together to form a ring-shaped drum. The drum is then cut ~~into the predetermined~~ to a prescribed width and rolled out to ~~constitute~~ create metal rings of a ~~predetermined~~ prescribed peripheral length. The metal rings are then subjected to a solution treatment ~~or the like~~, etc. This is followed by a peripheral length correction process, which is carried out by

a "peripheral length correction device" ~~to~~ for correcting the metal rings to ~~an accurate~~ precise peripheral length. The metal rings are further subjected to an aging treatment, nitriding, etc. ~~and the like~~ to enhance ~~their~~ metal hardness. A plurality of such metal rings (about ten mentioned above) which vary slightly in peripheral length ~~from one to the other are mutually layered~~ are laminated to one another to form a CVT belt. Thus, the peripheral length correction device is an important and indispensable device ~~to~~ for carrying out ~~the~~ lamination of ~~multiple~~ a plurality of ~~thin~~ metal rings to ~~form~~ constitute one CVT belt.

As a conventional prior art peripheral length correction device, there is a known device which carries a solution treat~~edment~~ and the ~~like~~ metal rings (hereinafter referred to as "receiving correction rings"), ~~that are~~ laid on two rollers (driving roller and driven roller) of which either or both are displaceable in mutually separating directions while rotating the rollers, and thereby applying tensile stress to the receiving correction rings ~~to~~ for correcting their peripheral length. This device is described in Japanese Laid-Open (Kokai) Patent Application (A) numbered 2001-105050 titled "METHOD FOR PERIPHERAL LENGTH CORRECTION OF METAL RINGS."

The conventional peripheral length correction device is useful in that each of the number of metal rings constituting a CVT belt is corrected to a shorter peripheral length for the inner side of the metal ring and a longer peripheral length for

the outer side of the metal ring. Therefore, the necessary peripheral length difference for layering the metal rings can be accordingly provided.

However, for example, when foreign substances (residual pieces of cutting metal ~~or the like, etc.~~) adhere to the surface of a metal ring in a preceding process (solution treatment ~~or the like, etc.~~) prior to the correction process, the foreign substances cut into the roller surface of the peripheral length correction device, and consequently creating a problem by causing damage to the rollers of the peripheral length correction device. Additionally, if the impaired roller is used as is, a number of defective metal rings with damaged surfaces will be produced. Consequently, this creates another problem of reduced production yield.

SUMMARY OF THE INVENTION

The present invention has been made for the purpose of solving the circumstances mentioned above. Accordingly, the object of the present invention is to provide a peripheral length correction device which does not damage the rollers even if foreign substances (residual pieces of cutting metal, etc. ~~or the like~~) have adhered to the surface of a metal ring in a preceding process (solution treatment, etc. ~~or the like~~) prior to the correction process, and prevent diminished production yield.

The present invention pertains to a peripheral length correction device of metal rings, wherein a metal ring is laid

on at least two rollers which are displaceable in mutually separating directions. One or both of the rollers are displaced while rotating the rollers, thereby applying tensile stress to the metal ring to correct the peripheral length thereof and is characterized in comprising: a removal means for removing foreign substances adhered to the inner peripheral surface of the metal ring, and a re-adhesion prevention means for preventing re-adhesion of the foreign substances removed by the removal means to the metal ring.

According to the invention, when foreign substances (residual pieces of cutting metal or the like) are adhered to the surface of a metal ring in a preceding process (solution treatment, ~~etc. or the like~~) prior to the correction process, the foreign substances are removed by the removal means, and re-adhesion of the removed foreign substances to the metal ring is prevented by the re-adhesion prevention means. Therefore, even if foreign substances are adhered to the surface of a metal ring, it is possible to prevent a reduction in yield by maintaining the quality of the metal rings without damaging the driving roller or the driven roller.

A preferred mode of the invention is that the removal means has an abutting body abutted on the inner peripheral surface of the metal ring with a predetermined pressing force.

According to this mode, by adjusting the pressing force applied to the abutting body to make it optimal, it is possible to effectively remove foreign substances from a substance

loosely adhered to the inner peripheral surface of the metal ring to a substance firmly adhered thereto.

The abutting body ~~is~~ can be a rotary brush made of a static free material.

According to this mode, costs can be reduced by simplifying the structure of the abutting body and generation of static electricity can be ~~prevented~~ avoided during removal of the foreign substances, whereby re-adhesion of the foreign substances can be prevented.

Alternatively, the re-adhesion prevention means suctions away the foreign substances removed by the removal means to prevent the re-adhesion thereof to the metal rings.

Corresponding to this mode, as the removed foreign substances are suctioned away by negative pressure, ~~or the like~~ etc., it is possible to prevent the re-adhesion of the foreign substances as a result of its simple configuration.

Furthermore, the abutting body is driven by a predetermined driving mechanism. The driving mechanism can move the abutting body in the short direction of the inner peripheral surface of the metal ring laid on the rollers. The abutting body is moved so that the separating distance in the direction vertical to the inner peripheral surface of the metal ring can be increased as the moving distance in the short direction becomes larger.

In this mode, the pressing force of the abutting body can be adjusted by controlling the ~~moving~~ amount of movement of the abutting body. Moreover, since the ~~moving~~ direction of movement

is set in the short direction of the inner peripheral surface of the metal ring laid on the rollers, it is possible to prevent interference between the metal ring and the abutting body by increasing the ~~moving~~ amount of movement of the abutting body in the short direction when the metal ring is handled to lay on the rollers.

The above and further objects and ~~novel~~ preferred features of the present invention will more fully appear from the following detailed description when the same is read in conjunction with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1**A to **1**D are respectively a top view, a side elevation view, a main section enlarged view, and a main section perspective view of a peripheral length correction device according to ~~of~~ an embodiment of the invention.

FIG. **2** is a view of the positional relationship between the rotary brush **5**c and the metal belt **4** in the foreign substance removal position.

FIG. **3** is a constitutional view of the foreign substance removal head **5** and its related components.

FIG. **4** is a state diagram of the foreign substance removal position, the standby position, and the foreign substance removal

head **5** in an optional position there between.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention will hereinafter be described in detail with reference to the preferred embodiments shown in the accompanying drawings.

FIGS. **1**A to **1**D are respectively a top view, a side elevation view, a main section enlarged view and a main section perspective view.

In the drawings, the peripheral length correction device of metal rings **1** has a driving roller **2** and a rotation-free driven roller **3** which are rotary-driven by a drive means (not shown). The two rollers (driving roller **2** and driven roller **3**) are displaceable in mutually separating directions. For example, a rotational axis position of one roller (hereinafter referred to as "driving roller **2**") is fixed, and a rotational axis position of the other roller (hereinafter referred to as "driven roller **3**") can be moved closer to or farther apart from the driving roller **2** within a predetermined range in a direction to the rotational axis of the driving roller **2**. The driven roller **3** indicated by dotted figure lines in the drawing represents a position ~~when~~ where it is moved closest to the driving roller **2** (hereinafter referred to as "closest position"). The driven roller **3** indicated by a solid line in the drawing represents a position ~~when~~ where it is moved outermost from the driving roller **2** (hereinafter referred to as "outermost position").

Initially when a peripheral length correction process is carried out, the driven roller **3** is moved to the closest position to lay the metal ring **4** on the driving roller **2** and the driven roller **3**. Then, after the driven roller **3** is moved toward the outermost position ~~by a proper amount~~ to take up the slack of the metal ring **4**, the driven roller **3** is moved to the outermost position while the driving roller **2** is rotary-driven. In this movement, applying pressure **P** on the driving roller **2** generates tensile stress on the metal ring in a peripheral direction, thus a peripheral length of the metal ring **4** can be extended (corrected) to a desired length through the adjusting of the amount of the pressure **P** and the applying duration thereof.

In the shown peripheral length correction device of metal rings **1**, the two rollers (driving roller **2** and driven roller **3**) are displaceable in the mutually separating positions and are displaced to apply the tensile stress to the metal ring **4**. However, the device is not limited to this configuration. For example, a third roller (correction roller) may be added. This correction roller may be displaced to apply tensile stress to the metal ring **4** as shown in Japanese patent application number 2001-105050 described above.

The peripheral length correction device of metal rings **1** of this embodiment is provided with the aforementioned components necessary for the peripheral length correction process, and moreover comprises the following characteristic components comprising the foreign substance removal head **5** and its accessory

components. That is, the foreign substance removal head **5** is constituted by mounting a rotary brush ~~5~~5c inside a cylindrical head cover **5**b which has an opening **5**a formed on part of the side face, and inserting a rotary shaft **5**d of the rotary brush **5**c through the head support pipe **5**e.

The head support pipe **5**e has such a constitution as negative pressure is applied from a later described pneumatic pump. This negative pressure is applied through the head support pipe **5**e to the opening **5**a of the head cover **5**b to make it function as a suction port. The rotary brush **5**c is rotary-driven in a predetermined direction by a later described rotary-driven section. The foreign substance removal head **5** can be freely moved between a shown position (hereinafter referred to as "foreign substance removal position") and a "standby position" (standby position when the metal ring **4** is installed) in a ~~described below~~ moving mechanism described below.

FIG. **2** is a view of a positional relationship between the rotary brush **5**c and the metal ring **4** in the foreign substance removal position. Now, assuming that foreign substances **4**a (residual pieces of cutting metal, etc. ~~or the like~~) are adhered to the inner peripheral surface of the metal ring **4** in ~~a~~ the preceding process (solution treatment, etc. ~~or the like~~) and the foreign substances 4a are left remaining in place, they will cut into the surface of the driving roller **2** or the driven roller **3** and damage the rollers. If the damaged roller(s) continues to be used, the metal ring **4** thereafter will be damaged when

the peripheral length correction process is performed. These defective products are then rejected and directly cause a reduction in production yield.

According to the embodiment, the rotary brush **5**c is rotated and abutted on the inner peripheral surface of the metal ring **4** by a proper pressing force making it possible to remove the foreign substances **4**a adhered to the inner peripheral surface of the metal ring **4**. Moreover, since the removed foreign substances **4**b are suctioned away by the negative pressure, it is also possible to prevent re-adhesion to the metal ring **4**. ~~Here, the material of the rotary brush 5c, a~~ A static free material such as horse hair or wool is preferably used as material of the rotary brush 5c. This material has the precise degree of toughness needed to remove the foreign substances **4**a firmly adhered to the inner peripheral surface of the metal ring **4**, is highly wear resistant and no static electricity is induced by contact with the metal ring **4**. Nylon or felt buff can also be used by being subjected to an antistatic treatment.

FIG. **3** is a block diagram of the foreign substance removal head **5** and its related components. In the drawing, the head support pipe **5**e of the foreign substance removal head **5** is attached to a substrate **6**. The rotary-driven section **7** of the rotary brush **5**c and a moving mechanism section **8** of the foreign substance removal head **5** are disposed on the substrate **6**. Both the rotary-driven section **7** and the moving mechanism section **8** use air pressure generated by a pneumatic pump **9** as a power source.

That is, the rotary-driven section **7** provides the rotary-drive for the rotary shaft 5d of the rotary brush 5c by means of receiving the air pressure from the pneumatic pump **9** (e.g., an air motor). The moving mechanism section **8** also receives air pressure to move the substrate **6** in both directions along a shown arrow **10**, and can move the foreign substance removal head **5** integrated with the substrate **6** between a "foreign substance removal position" and a "standby position" or to an optional position there between (e.g., an air cylinder).

The shown arrow **10** indicates a ~~right~~ downward right oblique traveling direction on a drawing surface, which means the following. Namely, if the short direction of the inner peripheral surface of the metal ring **4** laid on the driving roller **2** and the driven roller **3** is **LS**, the foreign substance removal head can be moved along this direction **LS**. As the moving distance in the short direction **LS** is larger (downward movement on the drawing surface is larger), a separating direction (distance in a right direction **LR** on the drawing surface) in the vertical direction of the inner peripheral surface of the metal ring **4** can be increased. That is, the shown arrow **10** means the combined direction of **LS** and **LR** (a vector direction).

The pneumatic pump **9** is designed to generate air pressure necessary for the power source of the rotary-driven section **7** and the moving mechanism section **8** and apply negative pressure ~~is applied~~ to the opening **5**a of the foreign substance removal head **5**. The air pressure generated at the pneumatic pump **9** is

supplied through flexible pipes **11** and **12** to ~~each of~~ both the ~~respective~~ rotary-driven section **7** and the moving mechanism section **8** when necessary~~.~~ (~~S~~specifically, when the rotary brush **5**c is rotated and when the substrate **6** is moved to the foreign substance removal position, the standby position or the optional position there between). The negative pressure generated at the pneumatic pump **9** is supplied through a flexible pipe **13** to the head support pipe **5**e ((when removing the foreign substances that are suctioned away)).

FIG. **4** is a state diagram of the foreign substance removal head **5** in the foreign substance removal position, the standby position and the optional position there between. In the drawing, **A** indicates the foreign substance removal position, **C** the standby position, and **B** the optional position there between. When the foreign substance removal head **5** is in the foreign substance removing position (**A**), the rotary brush **5**c is abutted on the inner peripheral surface of the metal ring **4** by a predetermined pressing force. The pressing force ~~reaches maximum~~ is at its highest when the position (position along the direction of the arrow **10**) of the foreign substance removal head **5** coincides with the foreign substance removal position (**A**). When slightly separated, the pressing force is reduced corresponding to the separating direction. Thus, simply by adjusting the ~~moving~~ amount of movement of the substrate **6** by the moving mechanism section **8**, it is possible to adjust the pressing force between the rotary brush **5**c and the inner peripheral surface of the metal

ring **4**.

Additionally, when the foreign substance removal head **5** is in the standby position (**C**) or a position near the standby position (**C**), the foreign substance removal head **5** is positioned lower than the setting position of the metal ring **4** (position when it is laid on the driving roller **2** and the driven roller **3**) in the drawing. Thus, as the foreign substance removal head **5** in the standby position does not interfere with the metal ring **4**, it never stands in the way when the metal ring **4** is laid on the driving roller **2** and the driven roller **3**.

As apparent from the foregoing, the peripheral length correction device of metal rings **1** of the embodiment can provide the following advantages.

(1) First, the driven roller **3** is moved to the closest position when the metal ring **4** is laid on the driving roller **2** and the driven roller **3**. Then the driven roller **3** is moved toward the outermost position by a proper amount to take up the slack of the metal ring **4**. Subsequently, when the driving roller **2** is rotary-driven and the driven roller **3** is moved toward the outermost position, pressure **P** is applied to the driving roller **2** while moving, whereby tensile stress can be applied in the peripheral direction of the metal ring **4**. As in the case of the conventional technology, by adjusting the amount of pressure **P** and the duration of application thereof, the peripheral length of the metal ring **4** can be extended (corrected).

(2) The rotary brush 5c is rotated and abutted on the inner

peripheral surface of the metal ring **4** by a proper pressing force, whereby the foreign substances **4**a adhered to the inner peripheral surface of the metal ring **4** can be removed. Moreover, since the removed foreign substances 44b are suctioned away by the negative pressure, re-adhesion thereof to the metal ring **4** can also be prevented.

(3) The rotary brush **5**c is abutted on the inner peripheral surface of the metal ring **4** by the predetermined pressing force. Although the pressing force reaches its maximum when the position of the foreign substance removal head **5** (position along the direction of the arrow **10**) coincides with the foreign substance removal position (**A**), when slightly separated, the pressing force is reduced corresponding to the separating distance. Thus, simply by adjusting the ~~moving~~ amount of movement of the substrate **6** by the moving mechanism section **8**, it is possible to adjust the pressing force between the rotary brush **5**c and the inner peripheral surface of the metal belt **4**.

(4) When the foreign substance removal head **5** is in the standby position (**C**) or in a position near the standby position (**C**), the foreign substance removal head **5** is positioned lower than the setting position of the metal ring **4** (position when it is laid on the driving roller **2** and the driven roller **3**). Thus, since the foreign substance removal head **5** in the standby position does not interfere with the metal ring **4**, it never stands in the way when the metal ring **4** is laid on the driving roller **2** and the driven roller **3**.

According to the embodiment, the foreign substances are removed by using the rotary brush **5c**. However, the invention is not limited to this as an abutting body other than the brush may be used. However, generally in the metal rings of a CVT belt, curves (also referred to as "crowning") are frequently formed in its sectional direction as contrivance of alignment during layering. Therefore, a preferable component such as a brush where the abutting portion ~~is freely deformed~~ can change is used from the standpoint of "fittability" to the curved surface.

Furthermore, according to the embodiment, the rotary-driven section **7** is fixed to the substrate **6**. However, in the form of the above operation, if the rotary-driven structure is attached to the substrate **6** through an elastic body, such as a coil spring to enable setting adjustment of the elastic body, the pressing force of the rotary brush **5c** to the metal ring **4** can be varied. ~~By~~ With such a structure, the foreign substance removal effect may be adjusted when necessary.

According to the present invention, if foreign substances (residual pieces of cutting metal ~~or the like, etc.~~) are adhered to the surface of a metal ring in the preceding process (solution treatment ~~or the like, etc.~~) prior to the correction process, the foreign substances are removed by the removal means, and re-adhesion of the removed foreign substances to the metal ring is prevented by the re-adhesion prevention means. Therefore, even if foreign substances are adhered to the surface of a metal ring, it is possible to prevent a reduction in production yield

by maintaining the quality of the metal rings without damaging the driving roller or the driven roller.

According to the preferred mode of the present invention, by adjusting the pressing force applied to the abutting body to make it optimal, it is possible to effectively remove foreign substances ranging from substances loosely adhered to the inner peripheral surface of the metal rings to substances firmly adhered thereto.

Costs can be reduced by simplifying the structure of the abutting body and generation of static electricity ~~can be prevented~~ avoided during the removal of foreign substances ~~removal,~~ whereby re-adhesion of the foreign substances can be prevented.

Alternatively, since the removed foreign substances are suctioned away by negative pressure, etc. ~~or the like~~, it is possible to prevent the re-adhesion of the foreign substances by its simple configuration.

Furthermore, the pressing force of the abutting body can be adjusted by controlling the ~~moving~~ amount of movement of the abutting body. Also, since the ~~moving~~ direction ~~of movement~~ is set in the short direction of the inner peripheral surface of the metal ring laid on the rollers, it is possible to prevent interferences between the metal ring and the abutting body by increasing the ~~moving~~ amount of movement of the abutting body in the short direction when the metal ring is laid on the rollers.

While the present invention has been described with

reference to the preferred embodiments thereof, the invention is not to be limited to the details given therein, but includes all the embodiments which fall within the scope of the appended claims.

As this invention may be embodied in several forms without departing from the spirit of the essential characteristics thereof, the present embodiments are therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within meets and bounds of the claims, or equivalence of such meets and bounds thereof are therefore intended to be embraced by the claims.

What is claimed is:

1. A peripheral length correction device of metal rings with a metal ring laid on at least two rollers, which are displaceable in mutually separating directions, and applies tensile stress to the metal ring by displacing one or both of the rollers while rotating said rollers to correct the peripheral length thereof, being characterized in comprising:

a removal means for removing foreign substances adhered to the inner peripheral surface of said metal ring; and

a re-adhesion prevention means for preventing re-adhesion of the foreign substances removed by said removal means to said metal ring.

2. The peripheral length correction device of metal rings as set forth in claim 1, wherein said removal means is characterized in having an abutting body abutted on the inner peripheral surface of said metal ring by a predetermined pressing force.

3. The peripheral length correction device of metal rings as set forth in claim 2, wherein said abutting body is characterized in being a rotary brush made of a static free material.

4. The peripheral length correction device of metal rings as set forth in claim 1, wherein said re-adhesion prevention means is characterized by means of suction removal of the foreign substances removed by said removal means and preventing the

re-adhesion thereof to said metal ring.

5. The peripheral length correction device of metal rings as set forth in claim 2, which is characterized by said abutting body is driven by a predetermined driving mechanism;

said driving mechanism can move said abutting body in a short direction of the inner peripheral surface of the metal ring laid on said rollers; and

said abutting body is moved in such a way that a separating distance in the direction vertical to the inner peripheral surface of said metal ring is increased as the moving distance in the short direction becomes larger.

ABSTRACT ~~OF THE DISCLOSURE~~

In the peripheral length correction device of metal rings, a metal ring is laid upon a driving roller and a driven roller which are displaceable in mutually separating directions. One or both of the rollers are displaced while rotating the rollers, thereby applying tensile stress to the metal ring to correct the peripheral length thereof. The peripheral length correction device of metal rings further comprises a foreign substance removal head ~~which functions as the removal means~~ for removing foreign substances adhered to the inner peripheral surface of the metal ring, and ~~as the re-adhesion prevention means~~ for preventing re-adhesion of ~~the~~ foreign substances removed ~~by the removal means~~ from the metal ring. ~~There is provided a peripheral length correction device of metal rings which can prevent the reduction in production yield without damaging the rollers even if foreign substances (residual pieces of cutting metal or the like) adhere to the surface of the metal ring in a preceding process (solution treatment or the like) prior to the correction process.~~

PERIPHERAL LENGTH CORRECTION DEVICE OF METAL RINGS

BACKGROUND OF THE INVENTION

The present invention relates to a peripheral length correction device of metal rings, and more particularly to a peripheral length correction device used for correcting the peripheral length of metal rings which constitute a V-belt type Continuously Variable Transmission belt (hereinafter referred to as "CVT belt").

Conventionally, there is a known CVT belt which is structured by layering about ten thin metal rings of 0.2 mm thickness in succession with steel metal elements inserted therein, as disclosed in "REALIZATION OF THE IDEAL MAXIMUM PERFORMANCE OF A CVT TRANSMISSION" by Tomomi Miyaji (non-patent literature).

The CVT belt of such a structure is manufactured as follows. First, the ends of the thin sheet metal, which are made of ultrahigh-strength steel such as marageing steel, are welded together to form a ring-shaped drum. The drum is then cut to a prescribed width and rolled out to create metal rings of a prescribed peripheral length. The metal rings are then subjected to a solution treatment, etc. This is followed by a peripheral length correction process, which is carried out by a "peripheral length correction device" for correcting the metal rings to precise peripheral length. The metal rings are further subjected to an aging treatment, nitriding, etc. to enhance metal hardness. A plurality of such metal rings (about ten mentioned above) which

vary slightly in peripheral length are laminated to one another to form a CVT belt. Thus, the peripheral length correction device is an important and indispensable device for carrying out lamination of a plurality of metal rings to constitute one CVT belt.

As a conventional prior art peripheral length correction device, there is a known device which carries a solution treatment and the metal rings (hereinafter referred to as "receiving correction rings"), that are laid on two rollers (driving roller and driven roller) of which either or both are displaceable in mutually separating directions while rotating the rollers, and thereby applying tensile stress to the receiving correction rings for correcting their peripheral length. This device is described in Japanese Laid-Open (Kokai) Patent Application (A) numbered 2001-105050 titled "METHOD FOR PERIPHERAL LENGTH CORRECTION OF METAL RINGS."

The conventional peripheral length correction device is useful in that each of the number of metal rings constituting a CVT belt is corrected to a shorter peripheral length for the inner side of the metal ring and a longer peripheral length for the outer side of the metal ring. Therefore, the necessary peripheral length difference for layering the metal rings can be accordingly provided.

However, for example, when foreign substances (residual pieces of cutting metal, etc.) adhere to the surface of a metal ring in a preceding process (solution treatment, etc.) prior

to the correction process, the foreign substances cut into the roller surface of the peripheral length correction device and consequently create a problem by causing damage to the rollers of the peripheral length correction device. Additionally, if the impaired roller is used as is, a number of defective metal rings with damaged surfaces will be produced. Consequently, this creates another problem of reduced production yield.

SUMMARY OF THE INVENTION

The present invention has been made for the purpose of solving the circumstances mentioned above. Accordingly, the object of the present invention is to provide a peripheral length correction device which does not damage the rollers even if foreign substances (residual pieces of cutting metal, etc.) have adhered to the surface of a metal ring in a preceding process (solution treatment, etc.) prior to the correction process, and prevent diminished production yield.

The present invention pertains to a peripheral length correction device of metal rings, wherein a metal ring is laid on at least two rollers which are displaceable in mutually separating directions. One or both of the rollers are displaced while rotating the rollers, thereby applying tensile stress to the metal ring to correct the peripheral length thereof and is characterized in comprising: a removal means for removing foreign substances adhered to the inner peripheral surface of the metal ring and a re-adhesion prevention means for preventing

re-adhesion of the foreign substances removed by the removal means to the metal ring.

According to the invention, when foreign substances (residual pieces of cutting metal or the like) are adhered to the surface of a metal ring in a preceding process (solution treatment, etc.) prior to the correction process, the foreign substances are removed by the removal means, and re-adhesion of the removed foreign substances to the metal ring is prevented by the re-adhesion prevention means. Therefore, even if foreign substances are adhered to the surface of a metal ring, it is possible to prevent a reduction in yield by maintaining the quality of the metal rings without damaging the driving roller or the driven roller.

A preferred mode of the invention is that the removal means has an abutting body abutted on the inner peripheral surface of the metal ring with a predetermined pressing force.

According to this mode, by adjusting the pressing force applied to the abutting body to make it optimal, it is possible to effectively remove foreign substances from a substance loosely adhered to the inner peripheral surface of the metal ring to a substance firmly adhered thereto.

The abutting body can be a rotary brush made of a static free material.

According to this mode, costs can be reduced by simplifying the structure of the abutting body and generation of static electricity can be avoided during removal of the foreign

substances, whereby re-adhesion of the foreign substances can be prevented.

Alternatively, the re-adhesion prevention means suctions away the foreign substances removed by the removal means to prevent the re-adhesion thereof to the metal rings.

Corresponding to this mode, as the removed foreign substances are suctioned away by negative pressure, etc., it is possible to prevent the re-adhesion of the foreign substances as a result of its simple configuration.

Furthermore, the abutting body is driven by a predetermined driving mechanism. The driving mechanism can move the abutting body in the short direction of the inner peripheral surface of the metal ring laid on the rollers. The abutting body is moved so that the separating distance in the direction vertical to the inner peripheral surface of the metal ring can be increased as the moving distance in the short direction becomes larger.

In this mode, the pressing force of the abutting body can be adjusted by controlling the amount of movement of the abutting body. Moreover, since the direction of movement is set in the short direction of the inner peripheral surface of the metal ring laid on the rollers, it is possible to prevent interference between the metal ring and the abutting body by increasing the amount of movement of the abutting body in the short direction when the metal ring is handled to lay on the rollers.

The above and further objects and preferred features of the present invention will more fully appear from the following

detailed description when the same is read in conjunction with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1**A to **1**D are respectively a top view, a side elevation view, a main section enlarged view and a main section perspective view of a peripheral length correction device according to an embodiment of the invention.

FIG. **2** is a view of the positional relationship between the rotary brush **5**c and the metal belt **4** in the foreign substance removal position.

FIG. **3** is a constitutional view of the foreign substance removal head **5** and its related components.

FIG. **4** is a state diagram of the foreign substance removal position, the standby position, and the foreign substance removal head **5** in an optional position there between.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention will hereinafter be described in detail with reference to the preferred embodiments shown in the accompanying drawings.

FIGS. **1**A to **1**D are respectively a top view, a side elevation view, a main section enlarged view and a main section perspective

view.

In the drawings, the peripheral length correction device of metal rings **1** has a driving roller **2** and a rotation-free driven roller **3** which are rotary-driven by a drive means (not shown). The two rollers (driving roller **2** and driven roller **3**) are displaceable in mutually separating directions. For example, a rotational axis position of one roller (hereinafter referred to as "driving roller **2**") is fixed, and a rotational axis position of the other roller (hereinafter referred to as "driven roller **3**") can be moved closer to or farther apart from the driving roller **2** within a predetermined range in a direction to the rotational axis of the driving roller **2**. The driven roller **3** indicated by dotted figure lines in the drawing represents a position where it is moved closest to the driving roller **2** (hereinafter referred to as "closest position"). The driven roller **3** indicated by a solid line in the drawing represents a position where it is moved outermost from the driving roller **2** (hereinafter referred to as "outermost position").

Initially when a peripheral length correction process is carried out, the driven roller **3** is moved to the closest position to lay the metal ring **4** on the driving roller **2** and the driven roller **3**. Then, after the driven roller **3** is moved toward the outermost position to take up the slack of the metal ring **4**, the driven roller **3** is moved to the outermost position while the driving roller **2** is rotary-driven. In this movement, applying pressure **P** on the driving roller **2** generates tensile stress on

the metal ring in a peripheral direction, thus a peripheral length of the metal ring **4** can be extended (corrected) to a desired length through the adjusting of the amount of the pressure **P** and the applying duration thereof.

In the shown peripheral length correction device of metal rings **1**, the two rollers (driving roller **2** and driven roller **3**) are displaceable in the mutually separating positions and are displaced to apply the tensile stress to the metal ring **4**. However, the device is not limited to this configuration. For example, a third roller (correction roller) may be added. This correction roller may be displaced to apply tensile stress to the metal ring **4** as shown in Japanese patent application number 2001-105050 described above.

The peripheral length correction device of metal rings **1** of this embodiment is provided with the aforementioned components necessary for the peripheral length correction process, and moreover comprises the following characteristic components comprising the foreign substance removal head **5** and its accessory components. That is, the foreign substance removal head **5** is constituted by mounting a rotary brush **5c** inside a cylindrical head cover **5b** which has an opening **5a** formed on part of the side face, and inserting a rotary shaft **5d** of the rotary brush **5c** through the head support pipe **5e**.

The head support pipe **5e** has such a constitution as negative pressure is applied from a later described pneumatic pump. This negative pressure is applied through the head support pipe **5e**

to the opening 5a of the head cover 5b to make it function as a suction port. The rotary brush 5c is rotary-driven in a predetermined direction by a later described rotary-driven section. The foreign substance removal head 5 can be freely moved between a shown position (hereinafter referred to as "foreign substance removal position") and a "standby position" (standby position when the metal ring 4 is installed) in a moving mechanism described below.

FIG. 2 is a view of a positional relationship between the rotary brush 5c and the metal ring 4 in the foreign substance removal position. Now, assuming that foreign substances 4a (residual pieces of cutting metal, etc.) are adhered to the inner peripheral surface of the metal ring 4 in the preceding process (solution treatment, etc.) and the foreign substances 4a are left remaining in place, they will cut into the surface of the driving roller 2 or the driven roller 3 and damage the rollers. If the damaged roller(s) continues to be used, the metal ring 4 thereafter will be damaged when the peripheral length correction process is performed. These defective products are then rejected and directly cause a reduction in production yield.

According to the embodiment, the rotary brush 5c is rotated and abutted on the inner peripheral surface of the metal ring 4 by a proper pressing force making it possible to remove the foreign substances 4a adhered to the inner peripheral surface of the metal ring 4. Moreover, since the removed foreign substances 4b are suctioned away by the negative pressure, it

is also possible to prevent re-adhesion to the metal ring **4**. A static free material such as horse hair or wool is preferably used as material of the rotary brush 5c. This material has the precise degree of toughness needed to remove the foreign substances **4**a firmly adhered to the inner peripheral surface of the metal ring **4**, is highly wear resistant and no static electricity is induced by contact with the metal ring **4**. Nylon or felt buff can also be used by being subjected to an antistatic treatment.

FIG. **3** is a block diagram of the foreign substance removal head **5** and its related components. In the drawing, the head support pipe **5**e of the foreign substance removal head **5** is attached to a substrate **6**. The rotary-driven section **7** of the rotary brush **5**c and a moving mechanism section **8** of the foreign substance removal head **5** are disposed on the substrate **6**. Both the rotary-driven section **7** and the moving mechanism section **8** use air pressure generated by a pneumatic pump **9** as a power source. That is, the rotary-driven section **7** provides the rotary-drive for the rotary shaft 5d of the rotary brush 5c by means of receiving the air pressure from the pneumatic pump **9** (e.g., an air motor). The moving mechanism section **8** also receives air pressure to move the substrate **6** in both directions along a shown arrow **10**, and can move the foreign substance removal head **5** integrated with the substrate **6** between a "foreign substance removal position" and a "standby position" or to an optional position there between (e.g., an air cylinder).

The shown arrow **10** indicates a downward right oblique traveling direction on a drawing surface, which means the following. Namely, if the short direction of the inner peripheral surface of the metal ring **4** laid on the driving roller **2** and the driven roller **3** is **LS**, the foreign substance removal head can be moved along this direction **LS**. As the moving distance in the short direction **LS** is larger (downward movement on the drawing surface is larger), a separating direction (distance in a right direction **LR** on the drawing surface) in the vertical direction of the inner peripheral surface of the metal ring **4** can be increased. That is, the shown arrow **10** means the combined direction of **LS** and **LR** (a vector direction).

The pneumatic pump **9** is designed to generate air pressure necessary for the power source of the rotary-driven section **7** and the moving mechanism section **8** and apply negative pressure to the opening **5a** of the foreign substance removal head **5**. The air pressure generated at the pneumatic pump **9** is supplied through flexible pipes **11** and **12** to both the rotary-driven section **7** and the moving mechanism section **8** when necessary (specifically, when the rotary brush **5c** is rotated and when the substrate **6** is moved to the foreign substance removal position, the standby position or the optional position there between). The negative pressure generated at the pneumatic pump **9** is supplied through a flexible pipe **13** to the head support pipe **5e** (when removing the foreign substances that are suctioned away).

FIG. **4** is a state diagram of the foreign substance removal

head **5** in the foreign substance removal position, the standby position and the optional position there between. In the drawing, **A** indicates the foreign substance removal position, **C** the standby position, and **B** the optional position there between. When the foreign substance removal head **5** is in the foreign substance removing position (**A**), the rotary brush **5**c is abutted on the inner peripheral surface of the metal ring **4** by a predetermined pressing force. The pressing force is at its highest when the position (position along the direction of the arrow **10**) of the foreign substance removal head **5** coincides with the foreign substance removal position (**A**). When slightly separated, the pressing force is reduced corresponding to the separating direction. Thus, simply by adjusting the amount of movement of the substrate **6** by the moving mechanism section **8**, it is possible to adjust the pressing force between the rotary brush **5**c and the inner peripheral surface of the metal ring **4**.

Additionally, when the foreign substance removal head **5** is in the standby position (**C**) or a position near the standby position (**C**), the foreign substance removal head **5** is positioned lower than the setting position of the metal ring **4** (position when it is laid on the driving roller **2** and the driven roller **3**) in the drawing. Thus, as the foreign substance removal head **5** in the standby position does not interfere with the metal ring **4**, it never stands in the way when the metal ring **4** is laid on the driving roller **2** and the driven roller **3**.

As apparent from the foregoing, the peripheral length correction

device of metal rings **1** of the embodiment can provide the following advantages.

(1) First, the driven roller **3** is moved to the closest position when the metal ring **4** is laid on the driving roller **2** and the driven roller **3**. Then the driven roller **3** is moved toward the outermost position by a proper amount to take up the slack of the metal ring **4**. Subsequently, when the driving roller **2** is rotary-driven and the driven roller **3** is moved toward the outermost position, pressure **P** is applied to the driving roller **2** while moving, whereby tensile stress can be applied in the peripheral direction of the metal ring **4**. As in the case of the conventional technology, by adjusting the amount of pressure **P** and the duration of application thereof, the peripheral length of the metal ring **4** can be extended (corrected).

(2) The rotary brush 5c is rotated and abutted on the inner peripheral surface of the metal ring **4** by a proper pressing force, whereby the foreign substances **4**a adhered to the inner peripheral surface of the metal ring **4** can be removed. Moreover, since the removed foreign substances **4**b are suctioned away by the negative pressure, re-adhesion thereof to the metal ring **4** can also be prevented.

3) The rotary brush **5**c is abutted on the inner peripheral surface of the metal ring **4** by the predetermined pressing force. Although the pressing force reaches its maximum when the position of the foreign substance removal head **5** (position along the direction of the arrow **10**) coincides with the foreign substance

removal position (**A**), when slightly separated, the pressing force is reduced corresponding to the separating distance. Thus, simply by adjusting the amount of movement of the substrate **6** by the moving mechanism section **8**, it is possible to adjust the pressing force between the rotary brush **5c** and the inner peripheral surface of the metal belt **4**.

4) When the foreign substance removal head **5** is in the standby position (**C**) or in a position near the standby position (**C**), the foreign substance removal head **5** is positioned lower than the setting position of the metal ring **4** (position when it is laid on the driving roller **2** and the driven roller **3**). Thus, since the foreign substance removal head **5** in the standby position does not interfere with the metal ring **4**, it never stands in the way when the metal ring **4** is laid on the driving roller **2** and the driven roller **3**.

According to the embodiment, the foreign substances are removed by using the rotary brush **5c**. However, the invention is not limited to this as an abutting body other than the brush may be used. However, generally in the metal rings of a CVT belt, curves (also referred to as "crowning") are frequently formed in its sectional direction as contrivance of alignment during layering. Therefore, a preferable component such as a brush where the abutting portion can change is used from the standpoint of "fittability" to the curved surface.

Furthermore, according to the embodiment, the rotary-driven section **7** is fixed to the substrate **6**. However,

in the form of the above operation, if the rotary-driven structure is attached to the substrate **6** through an elastic body, such as a coil spring to enable setting adjustment of the elastic body, the pressing force of the rotary brush **5**c to the metal ring **4** can be varied. With such a structure, the foreign substance removal effect may be adjusted when necessary.

According to the present invention, if foreign substances (residual pieces of cutting metal, etc.) are adhered to the surface of a metal ring in the preceding process (solution treatment, etc.) prior to the correction process, the foreign substances are removed by the removal means, and re-adhesion of the removed foreign substances to the metal ring is prevented by the re-adhesion prevention means. Therefore, even if foreign substances are adhered to the surface of a metal ring, it is possible to prevent a reduction in production yield by maintaining the quality of the metal rings without damaging the driving roller or the driven roller.

According to the preferred mode of the present invention, by adjusting the pressing force applied to the abutting body to make it optimal, it is possible to effectively remove foreign substances ranging from substances loosely adhered to the inner peripheral surface of the metal rings to substances firmly adhered thereto.

Costs can be reduced by simplifying the structure of the abutting body and generation of static electricity avoided during the removal of foreign substances whereby re-adhesion of the

foreign substances can be prevented.

Alternatively, since the removed foreign substances are suctioned away by negative pressure, etc., it is possible to prevent the re-adhesion of the foreign substances by its simple configuration.

Furthermore, the pressing force of the abutting body can be adjusted by controlling the amount of movement of the abutting body. Also, since the direction of movement is set in the short direction of the inner peripheral surface of the metal ring laid on the rollers, it is possible to prevent interferences between the metal ring and the abutting body by increasing the amount of movement of the abutting body in the short direction when the metal ring is laid on the rollers.

While the present invention has been described with reference to the preferred embodiments thereof, the invention is not to be limited to the details given therein, but includes all the embodiments which fall within the scope of the appended claims.

What is claimed is:

1. A peripheral length correction device of metal rings with a metal ring laid on at least two rollers, which are displaceable in mutually separating directions, and applies tensile stress to the metal ring by displacing one or both of the rollers while rotating said rollers to correct the peripheral length thereof, being characterized in comprising:

a removal means for removing foreign substances adhered to the inner peripheral surface of said metal ring; and

a re-adhesion prevention means for preventing re-adhesion of the foreign substances removed by said removal means to said metal ring.

2. The peripheral length correction device of metal rings as set forth in claim 1, wherein said removal means is characterized in having an abutting body abutted on the inner peripheral surface of said metal ring by a predetermined pressing force.

3. The peripheral length correction device of metal rings as set forth in claim 2, wherein said abutting body is characterized in being a rotary brush made of a static free material.

4. The peripheral length correction device of metal rings as set forth in claim 1, wherein said re-adhesion prevention means is characterized by means of suction removal of the foreign substances removed by said removal means and preventing the

re-adhesion thereof to said metal ring.

5. The peripheral length correction device of metal rings as set forth in claim 2, which is characterized by said abutting body is driven by a predetermined driving mechanism;

said driving mechanism can move said abutting body in a short direction of the inner peripheral surface of the metal ring laid on said rollers; and

said abutting body is moved in such a way that a separating distance in the direction vertical to the inner peripheral surface of said metal ring is increased as the moving distance in the short direction becomes larger.

ABSTRACT

In the peripheral length correction device of metal rings, a metal ring is laid upon a driving roller and a driven roller which are displaceable in mutually separating directions. One or both of the rollers are displaced while rotating the rollers, thereby applying tensile stress to the metal ring to correct the peripheral length thereof. The peripheral length correction device of metal rings further comprises a foreign substance removal head for removing foreign substances adhered to the inner peripheral surface of the metal ring and for preventing re-adhesion of foreign substances removed from the metal ring.